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# **Environmental Characteristics for EM Techniques in MCM**

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## **LONG-TERM GOAL**

The long term goal is to develop physics based models that will identify those spatial sediment properties, which result in significant changes and/or errors in the parameters of the Navy's MCM environmental model. The Navy will be required to respond to regional conflicts throughout the world over the next several decades. The tactical support for these operations within littoral regions will require accurate and timely environmental information. This is especially important for amphibious warfare and associated Mine-Counter Measure (MCM) efforts. Specifically, mine burial (either by impact or sediment transport/scour) depends strongly on bottom sediment type. Electrical properties, combined with seismo-acoustic properties provide a rapid method to predict sediment characteristics that are related to mine burial and magnetic influence sweeping. Data to optimize the sweep parameters are currently available in very few geographic locations throughout the entire world with little (if any) data on temporal changes.

## **OBJECTIVES**

Develop the technology to measure the spatial variations of electric properties of shallow marine sediments in a well defined geologic setting. Relate these variability's to MCM environmental parameters to support Navy influence mine sweeping operations and next generation mine hunting systems.

## **APPROACH**

The approach is to utilize frequency domain active electromagnetic sounding techniques to investigate the sub-bottom electrical properties in a well studied area. The electrical properties are determined by inverting the measured data for a simple layered model with the bottom electrical conductivity as a primary parameter. The electric conductivity of the bottom sediments can be related to the known geology and sedimentology of the area from other investigators. From the measured bottom properties, the spatial variation of the variability in MCM environmental parameters can be investigated. The first portion of the effort was devoted to the measurement of the electric and acoustic properties in a well studied and instrumented region during August 1996. This measurement area was located within ONR's STRATAFORM test area off the Eel River northern California, which provided an ideal site with a wide variety of co-located academic investigations to define the geologic environment.

## **WORK COMPLETED**

The measurement phase of the project was coordinated with related work of investigators from Scripps and Woods Hole and completed. Data from three bottom-deployed EM receiver units located near the STRATAFORM S60 site were obtained for analysis. In the previous year, interpretation software was refined to extract bottom electrical properties from the data. A paper (listed in references) has been developed and presented describing some of the initial results. Additional work has focused on analyzing the remaining radial towed-source track lines for the bottom properties. All of the usable electric field data has been analyzed.

## **RESULTS**

All of the usable electric field data have been inverted for bottom electrical properties. The resulting bottom properties are in agreement with the measurements conducted by Woods Hole. Some problems were encountered with the data inversion for bottom properties that increased the uncertainty of the results. Problems with the data were identified as due to an instability of the equipment system function or as errors in the transmitter-receiver relative position. These problems resulted in an increased uncertainty of the sub-bottom electrical properties. However, comparison with results from the Woods Hole EM survey were fairly good and supported the Woods Hole survey conclusions.

## **IMPACT/APPLICATION**

This work is focused on relating the bottom electrical properties to the local sediment distributions and the influence these factor have on MCM operations. The connection between the sediment properties and the resulting MCM environmental parameters is poorly understood. Simple models are available to relate the geology to the MCM parameters, but the quality, reliability and variability of the resulting MCM parameters has not been determined.

## **TRANSITIONS**

Data from this experiment have been transitioned to the NRL Multiple-Influence Detection task. The spatial variability in electrical properties can be utilized to determine the variability of MCM environmental parameters.

## **RELATED PROJECTS**

Related projects include projects within the ONR STRATAFORM program which have initiated detailed studies of the geology and oceanographic properties, this includes the electromagnetic survey work of Rob Evans at the Woods Hole Institute of Oceanography. Additional related work at NRL is the Multiple-Influence Detection task, which has investigated the effects of the environment on data fusion of different sensor types for ASW applications. This project has also worked closely with LeRoy Dorman at the Scripps Institute of Oceanography to incorporate seismic data into a data fusion detection technique.

## **REFERENCES**

Avera, W., E. Mozley, and J. Reynaud, Controlled Source Electromagnetic Sounding off the Coast of Eureka California, MARELEC 97 conference, Imperial College, London England, June 1997.